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Re:	802.16m AWD IEEE 802.16m-09/0012, "Call for Contributions for Project 802.16m Amendment Working Document (AWD) Content" Target topic: "Power Control"
Abstract	The contribution proposes the text of a power control section to be included in the 802.16m amendment.
Purpose	To be discussed and adopted by TGm for the 802.16m amendment.
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Proposed Text of Power Control Section for the IEEE 802.16m Amendment

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1. Introduction

It is imperative that OFDMA uplink systems adopt power control in order not only to maximize system performances but also to minimize the bettery consumption of mobile stations (MSs). In this contribution, a power control algorithm and a method to control interference over thermal (IoT) noise level are described.

2. Uplink Fast Power Control

Compared to slow power control schemes which make up for only long term path loss and shadowing effect, fast power control schemes can provide additional link level gain. This is because fast power control makes the received SNR being constant by compensating the short term fast fading effect additionally.

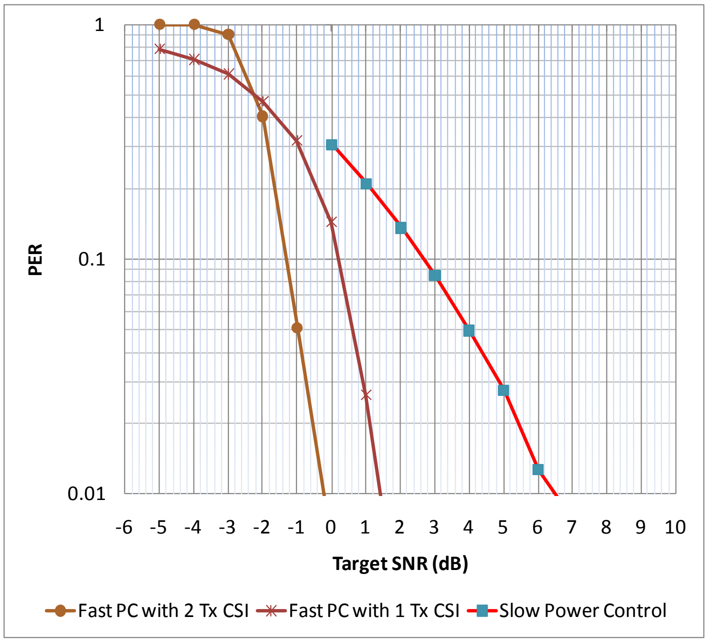


Figure 1. Link gain of fast power control over slow power control

Figure 1 shows the link gain of fast power control in terms of target SNR (dB). The channel used for simulation is 1x2 single input multiple output (SIMO) channel where the receiver exploits two Rx antenna with MRC-manner. More investigation of fast power control gain can be found in [1].

Fast power control can be implemented in two ways. One is closed loop manner and the other is open loop manner. Generally, TDD systems can benefit from fast power control using open loop, because downlink and uplink channel has a characteristics of reciprocity. On the other hand, FDD systems have to use closed loop power control in order to exploit fast power control.

2.1. Closed Loop Power Control

In closed loop power control (CLPC) schemes, 16m base station (BS) sends power control command which should order MS to increase or decrease its transmission power by pre-defined amount. Power control command for a MS is determined by serving BS and based on the estimated channel information or SINR value of MS. In order to estimate uplink channel or SINR value, there shall be a kind of reference signals. Latest transmitted data signal or periodically transmitted control signal like UL FBCH can be one of them. After BS determines the amount of changing power, BS transmits the information through power control channel.

In an example of Figure 1, optimal way to control transmission power is to adjust two uplink channels, respectively. This case shows best performance because the received SNR can be kept constantly if there is not any impairment ocurred by information mismatch.

Once again, operation of CLPC requires the following essential factors;

- Uplink reference signals for estmation
- Downlink control channel where CLPC commands are put into

Note that signaling overhead for downlink control channel where CLPC commands are transmitted by is inevitable for CLPC operation intrinsically.

As for differences of CLPC operation in FDD and TDD systems, delay between estimation of uplink channel and the next transmission is one marked difference. Since TDD systems' inherent characteristics of frame structure, delay is larger than that of FDD systems. This delay impacts on the accuracy of power control and results in the gain of fast power control. Figure 2 shows the delay of FDD systems in (a) and TDD systems in (b). In FDD systems, the delay is 4 subframes since there always are downlink and uplink subframes. In TDD systems, however, the delay is 8 subframes as shown in the figure.

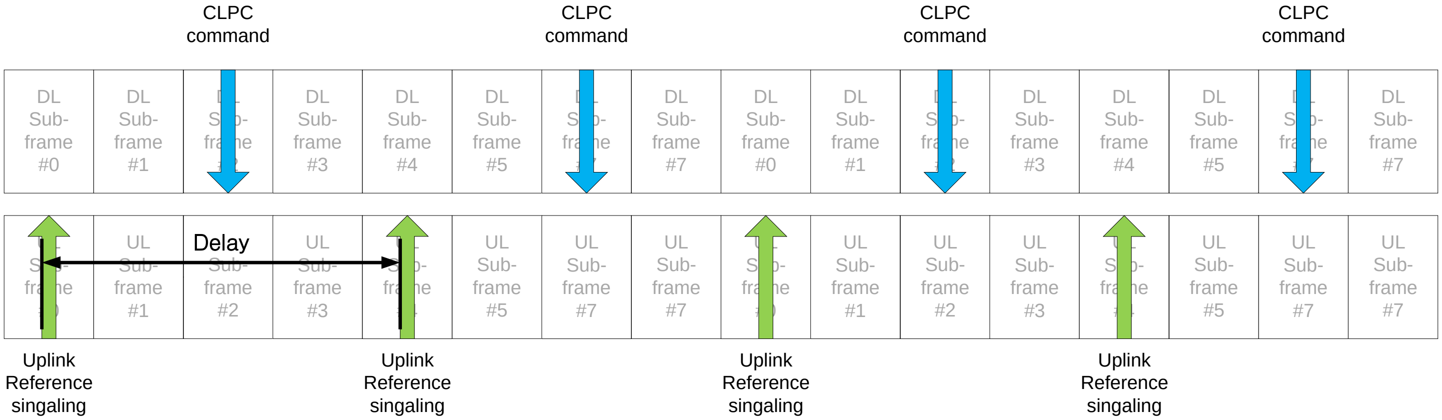


Figure 2 (a) Delay between uplink channel estimation and the next transmission in FDD systems

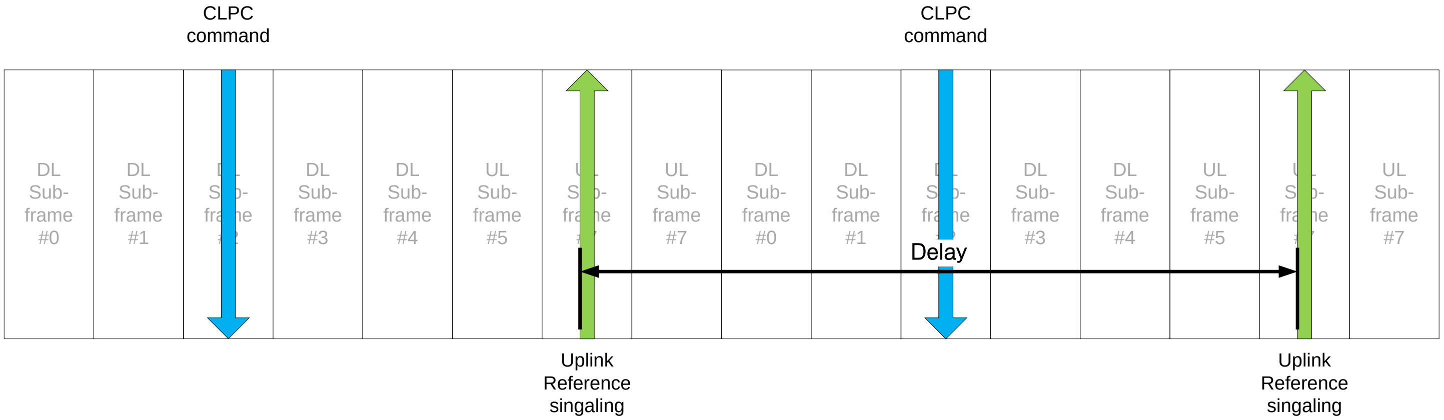


Figure 2 (b) Delay between uplink channel estimation and the next transmission in TDD systems

Please refer to [2] for downlink control channel for CLPC command.

2.2. Open Loop Power Control

Fast power control using OLPC is viable only in TDD systems since channel reciprocity is not valid in FDD systems.

Based on estimation of downlink channel, MS calculates the required transmitted power which should consider pathloss, shadowing and short term fading. Of course, in order to guarantee the received SINR at BS, MS also needs information such as uplink noise and interference (NI) level, and target SINR value for specific MCS level including uplink control transmission. Unlike transmit power control (TPC) commands of CLPC, however, these information is based on long-term statistics. Therefore signaling overhead for operation of OLPC is basically lower than that of CLPC.

Operation of OLPC requires the following essential factors;

- Uplink NI level which should be broadcasted by serving BS
- Target SINR for all transmission schemes including modulation and coding scheme (MCS) and uplink control channels

3. Interference Level Control

In interference limited environment, OFDMA-based uplink system is sensitive to interference level. There is a relationship of trade-off between average sector throughput and cell edge performance. Usually sector throughput is monotonously increased as interference over thermal noise (IoT) level is getting large. However, at some point, the increase is losing its efficiency as shown in Figure 3.

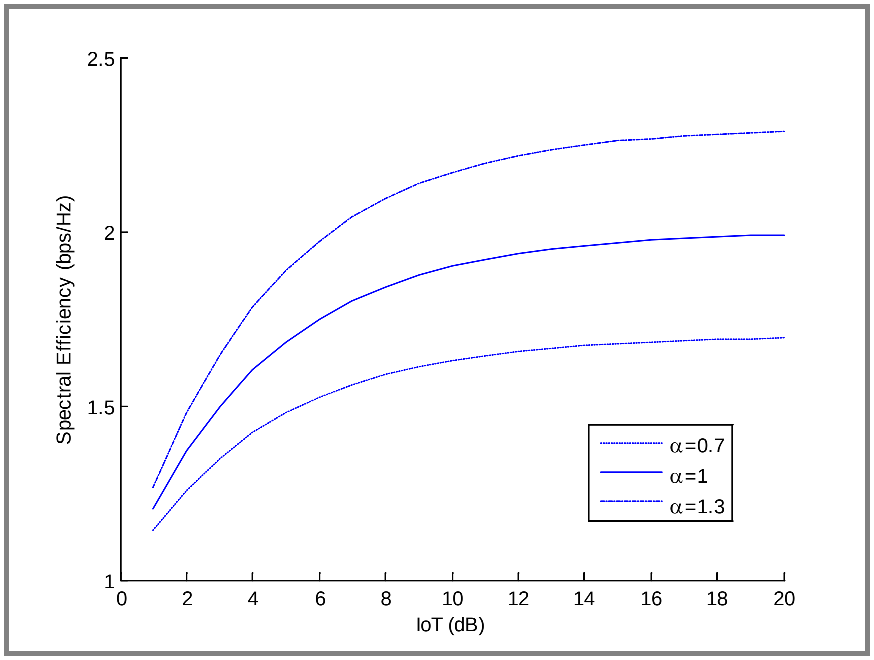


Figure 3. System throughput according to IoT level

In the Figure 3, spectral efficiency (SE) in interference limited system is obtained by the followings.

- $SE = \log_2\left(1 + a\frac{S}{I+N}\right) = \log_2\left(1 + \alpha\left(1 - 1/IoT\right)\right)$

where α is fitting factor reflecting system average S/I and system overhead.

On the other hand, cell edge performance is not regularly increasing along with IoT level. With a given operation environment and system parameters, there should be optimal IoT level where the cell edge performance can be maximized. In this sense, even though systems have same operational numerologies, it is natural that the systems show different performances according to its IoT level. This is why IMT.EVAL suggests the IoT level restriction be 10dB [3] so that comparisons among various proposals are based on fair condition.

Uplink IoT level can be adjusted on target by controlling transmission power of mobile stations. In order to satisfy the target IoT level, various algorithms of power control in detail can be adopted and applied [4-6]. In this contribution, a approach on controlling uplink IoT level is introduced.

3.1. Definition of Load

In order to satisfy the required link performance (e.g. packet error rate 10%), uplink transmission for a MS in OFDMA systems should be power-controlled. Larger tone power is necessary for transmissions with higher MCS and smaller tone power vice versa. Together with the size of the assigned resource, the tone power requirement according to MCS level determines the total Tx power of the MS. The following equation shows the Tx power for a tone in OLPC of IEEE 802.16e.

$$P_{Tx} = NI + L_{pathloss} + C/N(mcs) + Offset_{BS} + Offset_{MS} , \quad (1)$$

where NI is noise and interference level broadcasted by serving BS, $L_{pathloss}$ is estimated pathloss (in TDD systems, this could include short term fading) and $C/N(mcs)$ is predefined required SINR for MCS mcs. $Offset_{BS}$

and $Offset_{MS}$ are compensation factors which are controlled by BS and by MS respectively.

If the MS transmits with the power determined according to (1), the required received SINR would be satisfied if any impairment is not occurred. At the same time, this transmitted signal acts as an interference to the neighbor BSs adjacent to the serving BS of the MS.

In order to control IoT level efficiently, the load of the m-th MS, κ_m, is defined as the total amount of interference impacting on all neighbor BSs by the MS. The load value is proportional to target received power at the serving BS and reversely proportional to the downlink SINR value. Consequently, the load of m-th MS can be approximated as

$$\kappa_m(n) = \frac{P_{Rx,Target}^{MS,m}(n)}{SINR^{DL,m}(n-1)}, \tag{2}$$

where n is the frame index, $P_{Rx,Target}^{MS,m}$ is the target Tx power of the MS for the specific MCS level and assigned resource size and $SINR^{DL,m}$ is downlink SINR value. The target Tx power is determined by uplink NI level, MCS, and resource size for the MS, resulting in the following equation:

$$P_{Rx,T\arg et}^{UL}(n) = P_{Tx}^{UL}(n) \times L^{UL} \tag{3}$$

The downlink SINR value is expressed by

$$SINR^{DL,m}(n-1) = \frac{P_{Tx}^{BS,0}(n-1) \times L^{DL,0}}{\sum_{i=1}^{I} P_{Tx}^{BS,i}(n-1) \times L^{DL,i} + P_{AWGN}} \tag{4}$$

Here we make several assumptions in order to understand the definition intuitively.

- If the uplink system is interference limited environments, then the downlink system is also interference limited because the power of BS is usually much stronger than MS. Therefore P_{AWGN} can be assumed to be ignored in the equation.
- Tx power of every BS is identical, i.e. $P_{Tx}^{BS,i} = P_{Tx}^{BS,j}$ for all i and j, i≠j
- There is no difference between downlink and uplink path loss, $L^{UL} = L^{DL}$

Combining (3) and (4) with the consideration of the assumptions above, we can obtain the following equation, by which we can intuitively interpret the load.

$$\kappa_m(n) = \sum_{i=1}^{I} P_{Tx}^{UL}(n) \times L^{DL,i} . \tag{5}$$

When BS assigns a MS a specific MCS and resource size, BS can calculate the load of the MS by (5). And this load can be interpreted as total received power at all neighbor BSs. Note that this load value is calculated for every MS which is going to be scheduled.

3.2. Proposed IoT Control Technique

The goal of load control is to keep IoT level close to the target IoT value. It is assumed that the IoT level averaged among all sectors is used. This is a little different from the goal of keeping the IoT level of EACH sector close to target value. As shown in the following sections, this simplification leads to easy implementation, simple algorithm, and minimized signaling overhead between BSs.

After receiving an uplink frame, a BS could calculate the IoT value averaged over the frame (frame is frequency and time domain). All instant IoT values are reported to a central controller (e.g., ASN-GATE) for further averaging as follows,

$$IoT_{avg} = \frac{1}{N}\sum_{n=1}^{N} IoT_n \quad , \tag{6}$$

where N is the total number of sectors which are controlled by an ASN-GATE.

The averaged value among all BSs is fed back to every BS and is used for BS to compare with target IoT. If the averaged IoT value is lower than the target, then the threshold of load is updated with increase of step and vice versa.

$$\begin{cases} K = K \times \Delta & if \;\; IoT_{avg} < IoT_{Target} \\ K = K / \Delta & if \;\; IoT_{avg} > IoT_{Target} \end{cases} \quad , \tag{7}$$

where K is the threshold of load and Δ is the step size for increase or decrease of K. Note that the threshold of load K is a common value for all sectors in this proposal.

Then, the updated threshold of load K is used when a serving BS schedules the MS. When BS schedules the m-th MS, this threshold value K is considered as a constraint of scheduling. Since the load value of the m-th MS in (2) changes along with MCS level and the size of resource allocation, BS should choose the MCS level and resource allocation which satisfy the constraint as follows,

$$\kappa_m(n) \le \mathrm{K} \,, \tag{8}$$

where $\kappa_m(n)$ is the load value of the m-th MS and dependent on the MCS and the size of resource which are going to be assigned to the m-th MS.

In summary, a load threshold K is updated based on comparing target IoT and the averaged IoT among all BSs. Once K is updated, every MS is scheduled with the constraint that the load value of the MS should be lower than K.

3.3. Operation Scenario

After an MS’s registration with the network and successful initial ranging, the MS could start sending downlink channel quality indication (CQI) feedback periodically as long as the MS stays in active mode. At the serving BS, the CQI information can be used in (2) in place of downlink SINR value. This results in quantization noise, but this is proven as ignorable in the following investigation.

When a BS schedules uplink transmission, BS decides which MSs should be assigned for the next uplink frame. This decision is made based on consideration of several criteria, e.g., quality of service (QoS), priority of MSs, etc. As one MS is selected, BS also determines the MCS level and allocates resources for the MS. In the process of MCS selection and resource allocation, (8) is additionally considered. By doing so, uplink IoT level could be maintained close to the target IoT.

3.4. Impairment in Practical Situation

The proposed algorithm has one important merit compared to other techniques – there is no additional signaling required over the air for interference control. We can see that the only variable the serving BS needs to know is downlink SINR of MSs in (2) which could be replaced by CQI reported to BS periodically by MS. Note that, however, CQI report contains quantization error and feedback delay in practical situation because instant and analog CQI report is not feasible. In the simulation results in the next section, the effect of

- Feedback quantization noise
- feedback delay
- feedback period

is further investigated.

3.5. Effect of Load Control on System Performance

In this section, SLS results are provided and analyzed. The parameters and assumptions of the simulations are aligned with NGMN configuration in [7].

3.5.1.Parameters and assumptions for Simulation

Table I shows the key system parameters for simulation. Please refer to [7] for other parameters and modeling of BS and MS in details.

Table II shows the assumptions for simulation and scheduling. Note in the table, that the maximum and minimum number of subchannel one MS can be assigned is 7 and 3, respectively. This means an MS is limited to 7 subchannels even if it has enough power to transmit more than 7 subchannels with the highest MCS. On the other hand, an MS is guaranteed to have 3 subchannels even if the MS is short of Tx power even for only 3 subchannels with the lowest MCS.

TABLE I. SYSTEM PARAMETERS

Parameter	**Value**
Carrier frequency (GHz)	2.5 GHz
Sampling frequency (MHz)	11.2 MHz
Inter site distance (m)	500m
System and frame structure	TDD and DL:UL=29:18
Number of symbols for data	15
FFT size (tone)	1024
Useful tone	840
Permutation	802.16e UL PUSC
Antenna and receiver	1×2 and MMSE
PHY Abstraction	RBIR
HARQ type and Max. ReTx	Chase combining and 5
Outer loop rate control	ON

TABLE II. ASSUMPTIONS FOR SIMULATION AND SCHEDULING

Parameter	Value
Traffic type	Full queue
MS channel type	3km/h, 100%
Channel estimation	Ideal
Max. number of PUSC subchannel assgined for a MS	7
Min. number of PUSC subchannel assigned for a MS	3
Scheduling priority method	PF
PF exponent	1
Total number of users per sector	20
Max. MS Tx power	23 dBm

3.5.2.Sector and Cell Edge Throughput

Figure 4 shows the system level results as target IoT level increases from 2dB to 16dB. System level results include both the average sector throughput and the cell edge MS performance. Note that cell edge MS is defined as 5%-tile MS among total MSs during total simulation drops. Bar graph with shadow is sector throughput, bar graph with white color is average IoT level and line with white square mark is cell edge throughput.

Three kinds of observations can be made from the figure. The first is that the proposed algorithm works very well as the actual averaged IoT level is very close to the target IoT.

Secondly, the average sector throughput monotonously increases with the IoT level. One important fact is that the throughput increase much faster as IoT increases when the IoT level is low. However as IoT becomes large, the required IoT increase for the same percentage of throughput increase is much larger. Table III shows the required amount to increase10% sector throughput. When IoT is 2dB, only 0.7dB increase is required while 4dB increase is required if the IoT is 6dB.

The final point in Figure 4 is that there is an IoT level that maximizes cell edge performance. In the figure, cell edge performance is maximized when IoT is around 8dB~10dB.

Taking everything into consideration, setting target IoT to 10dB seems reasonable because cell edge performance has almost peak value and sector throughput is also almost converged.

TABLE III. IOT AMOUNT FOR 10% INCREASE OF SECTOR THROUGHPUT

IoT (dB)	2	4	6	8
Sector throughput (Mbps)	2.02	2.60	2.85	3.0
IoT value for 10% increase	2.7	6	10	N/A
Required amount (dB)	0.7	2	4	N/A

Note: The required increase amount could change for different system parameters and assumptions

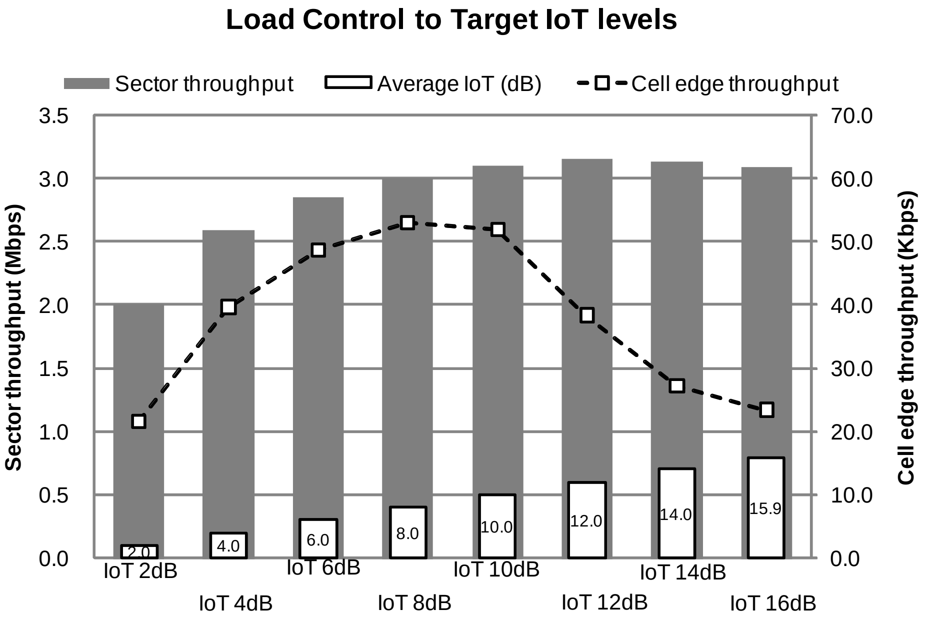


Figure 4. System performance along with target IoT level

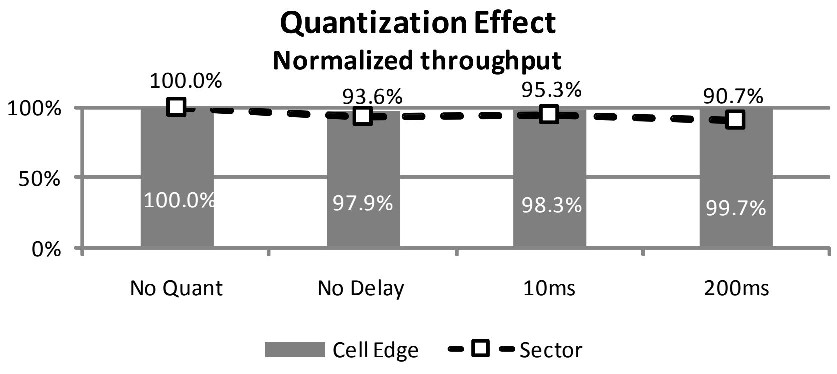
3.5.3.Effect of Practical Impairment on System Performance

Mismatch with perfect information of downlink SINR would occur due to three kinds of impairments:

- Quantization of downlink SINR
- Feedback delay of downlink SINR report
- Period of downlink SINR report.

These impairments might impact the accuracy of IoT control in the proposed algorithm. In this section, the effect of impairment is investigated through simulations.

Figure 5 shows the effect of quantization of downlink SINR report. Compared with the case without quantization, the case with quantization shows little degradation for both sector and cell edge throughput. The degradation is only 2% and 6% for sector and cell edge performance, respectively. This is because even without quantization, accurate MCS selection and resource allocation according to perfect downlink CINR is not possible anyway.



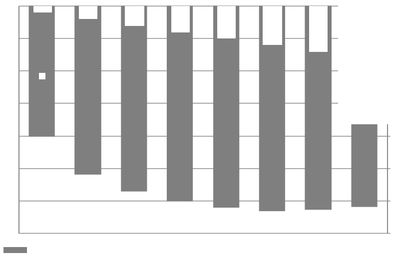


Figure 5. Effect of feedback quantization on the proposed technique

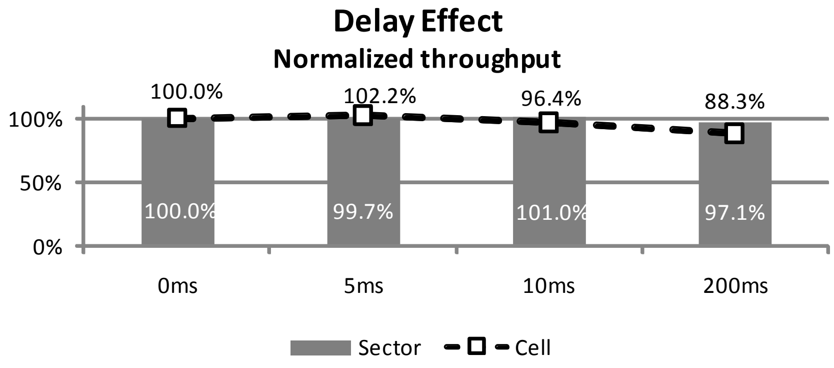


Figure 6. Effect of feedback delay on the proposed technique

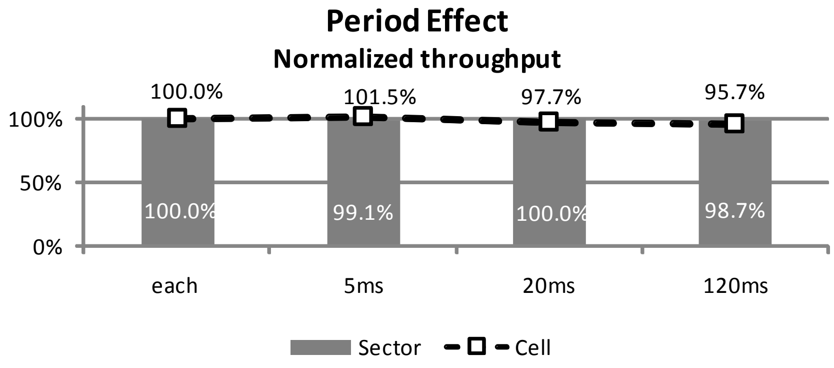


Figure 7. Effect of feedback period on the proposed technique

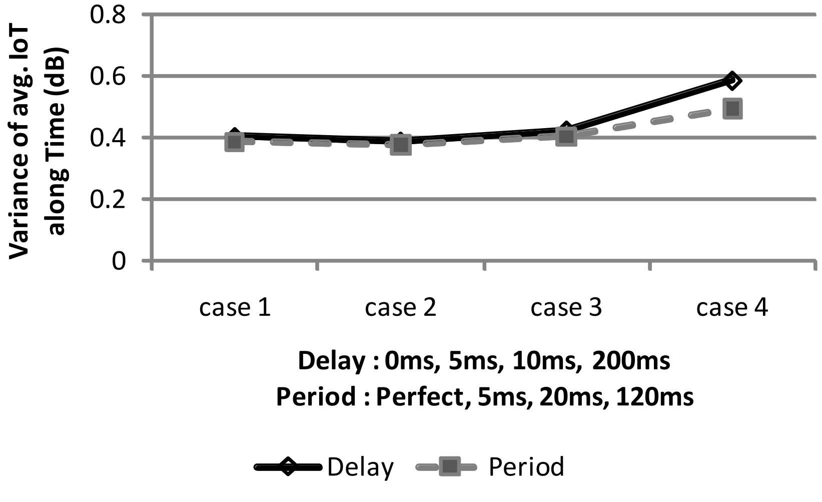


Figure 8. System performance along with target IoT level

Similarly, effect of feedback delay and effect of report period are provided in Figure 6 and Figure 7. As long as reasonable operational assumptions are used, performance degradation is hardly observed.

Figure 8 shows the time variance of averaged IoT among sectors. Since delay and period impact on the accuracy of IoT control, the variance of instantaneous IoT level a little bit increases as the delay and feedback period increases.

However, as shown in Figure 4, the IoT range that provides close-to-optimal system throughput and cell edge performance is wide. A small increase of instantaneous IoT variance does not cause noticeable performance degradation. This is why impairments mentioned above hardly impact on the system performance.

3.6. Remarks on the proposed algorithm

The proposed algorithm aims for providing uplink systems with an accurate IoT control method. No additional signaling overhead between MS and BS is required for the operation of proposed algorithm. The CQI information that would be already reported can be utilized for this algorithm.

As for practical consideration, the algorithm is also proven to be robust to implementation impairments such as quantization, various feedback delay values, and feedback periods.

Throughout results, we can conclude that a system can operate for its own purposes; if a BS wants to increase cell edge performance, the system can pick up the IoT level which would maximize the cell edge performance. On the other hand, the system can maximize the average sector throughput for a little sacrifice of cell edge performance by targetting other IoT level.

4. Necessary Signaling for Power Control

Fast uplink power contol requires signaling which include information for setting transmission power. Those signalings are different for CLPC and OLPC schemes

4.1. Closed loop power control

- PC-A-MAP

PC-A-MAP contains PC-A-MAP-IEs where a PC-A-MAP-IE includes 2 bit information. Table IV shows the PC-A-MAP IE format [2]. The 2 bit information is encoded as shown in Figure 9 [2].

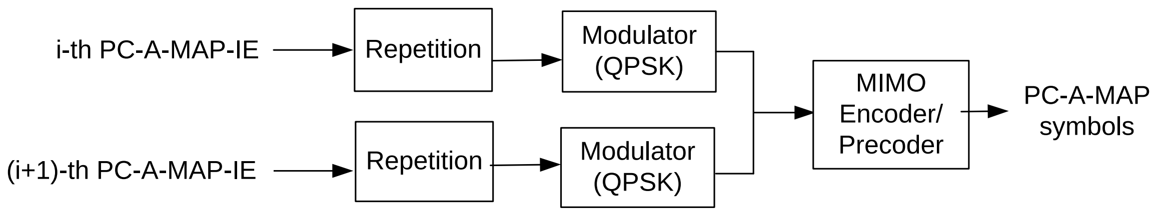


Figure 9. Block diagram of PC-A-MAP IE to PC-A-MAP symbols9

If PC-A-MAP IE has the 0b00, it shall be interpreted as tone power (power density) should be reduced by 0.5dB

TABLE IV. PC-A-MAP IE FORMAT

Syntax	Size	Notes

	(bit)	
PC-A-MAP IE format {		
Power correction value	2	0b00 = -0.5 dB 0b01 = 0.0 dB 0b10 = 0.5 dB 0b11 = 1.0 dB
}		

4.2. Open loop power control

- Noise and interference level in SFH

NI level information contains uplink noise and interference level which should be considered by all MSs who are going to transmit in OLPC mannner. Since NI level could be different for each frequency partition, NI level should be broadcasted for each frequency partition basically.

Syntax	Size (bit)	Notes
For (i=0; i<FPCT; i++){		
UL_Noise_and_Interference_Level_FP$_i$	8	Estimated average power level (dBm) per a subcarrier in the i-th frequency partition, FP$_i$ * The level shall be quantized in 0.5dBm step from -150 dBm to -22.5 dBm
}		

- Target SINR for every MCS & transmission scheme

Every different transmission scheme has its own required SINR which would guarantee the target error rate. In order to set tone power for uplink transmissioin, the required SINR should be recognized by all MS. Table V shows the example of target SINR list.

TABLE V. NORMALIZED C/N PER MODULATION

Modulation/FEC rate	**Required C/N**
HARQ Feedback CH	
PFB CH	
SFB CH	
BWREQ CH	
Ranging CH	
Sounding CH Class 1	
Sounding CH Class 2	
Sounding CH Class 3	
Sounding CH Class 4	
MCS index ‘0000’	

MCS index ‘0001’	
MCS index ‘0010’	
MCS index ‘0011’	
MCS index ‘0100’	
MCS index ‘0101’	
MCS index ‘0110’	
MCS index ‘0111’	
MCS index ‘1000’	
MCS index ‘1001’	
MCS index ‘1010’	
MCS index ‘1011’	
MCS index ‘1100’	
MCS index ‘1101’	
MCS index ‘1110’	
MCS index ‘1111’	

5. References

[1] *16m Power Control Channel Design*, IEEE C802.16m-09/0207r1

[2] *Document from DG (drafting group) of downlink control*, IEEE C802.16m-09/0558

[3] *DRAFT NEW REPORT ITU-R M.[IMT.EVAL], “Guidelines for evaluation of radio interface technologies for IMT-Advanced”*, ITU-R Study Groups

[4] *Uplink Power Control Recommendations for IEEE 802.16m*, IEEE C80216m-08/666r2

[5] *Uplink Power Control Design - Considerations and Mechanism*, IEEE C80216m-08/813

[6] *IEEE 802.16m UL Fractional Power Control*, IEEE C80216m-08/627

[7] *IEEE 802.16m Evaluation methodology Document*, IEEE 802.16m-08/004r5

6. Text proposal for inclusion in the 802.16m amendment

-- Text Start --

15.3.x Control Mechanisms

15.3.x.y Uplink power control

The uplink power control algorithm determines the power of subcarriers assigned to a AMS to compensate for the pathloss, shadowing and fast fading. ABS shall transmit necessary information to AMSs where the parameters of power control algorithm are optimized on system-wide basis by the ABS and broadcasted periodically. AMS can transmit necessary information to ABS to support uplink power control. ABS can exchange necessary information with neighbor ABSs through backbone network to support uplink power control.

AMS shall maintain the same tone power, unless the maximum power level is reached. In other words, when the number of active resource block allocated to a user is reduced, the total transmitted power shall be reduced proportionally by the AMS, without additional power control messages. When the number of resource blocks is increased, the total transmitted power shall also be increased proportionally. However, the total transmission power level shall not exceed the maximum levels dictated by signal integrity considerations and regulatory requirements. The AMS shall interpret power control messages as the required changes to the transmitted power density, i.e. tone power. If more than two different bursts are transmitted simultaneously, e.g. one data burst and fast feedback control channel, tone power is determined independently.

15.3.x.y.1 Closed loop power control

For fast closed loop power control, once PC-A-MAP is set up by upper entity, PC-A-MAP-IE is transmitted in order to adjust AMS's Tx power level and provide fast link adaptation.

The AMS shall report the maximum available power and the normalized transmitted power. The maximum available power may be reported in negotiation process of system entry. The current normalized transmitted power shall also be reported to ABS. The current transmitted power is the power of current burst that is carrying the message. The current transmitted power and the maximum power parameters are reported in dBm. The parameters are quantized to the nearest integer multiples of 0.5 dBm, ranging from -64 dBm (encoded 0x00) to 63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.

To maintain at the ABS a power density consistent with the modulation and FEC rate used by each AMS, the ABS may change the AMS's TX power through PC-A-MAP, as well as the AMS-assigned modulation and FEC rate. Upon transmission, the AMS shall use a temporary TX power value set according to (1) (in decibels).

$$P_{new} = P_{last} + (C/N_{new} - C/N_{last}) - (10\log_{10}(R_{new}) - 10\log_{10}(R_{last})) + offset \qquad (1)$$

where

- P_{new} = the power of the new UL burst in the current frame
- C/N_{new} = normalized C/N for the new UL burst in the current frame
- R_{new} = repetition factor R for the new UL burst in the current frame
- P_{last} = the power of the burst in the most recently transmitted frame
- C/N_{last} = normalized C/N associated with P_{last} (thus referring to the burst in the most recently transmitted UL frame)

- R_{last} = repetition factor R associated with P_{last} (thus referring to the burst in the most recently transmitted UL frame)
- $offset$ = an accumulation of PC-A-MAP-IE sent by the ABS since the last transmission.

Initial terms P_{new}, P_{last}, C/N_{new}, C/N_{last}, R_{new}, and R_{last} in closed loop power control (1) are obtained from the ranging process. The initial term P_{last} is the transmitted ranging power, C/N_{last} is the required C/N of ranging code in the Table 1, and R_{last} is zero. Initial terms P_{new}, C/N_{new}, and R_{new} are those of the first UL burst transmission with specific uplink transmission type.

Table 1 – Normalized C/N per modulation

Modulation/FEC rate	**Required C/N**
HARQ Feedback CH	
PFB CH	
SFB CH	
BWREQ CH	
Ranging CH	
Sounding CH Class 1	
Sounding CH Class 2	
Sounding CH Class 3	
Sounding CH Class 4	
MCS index ‘0000’	
MCS index ‘0001’	
MCS index ‘0010’	
MCS index ‘0011’	
MCS index ‘0100’	
MCS index ‘0101’	
MCS index ‘0110’	
MCS index ‘0111’	
MCS index ‘1000’	
MCS index ‘1001’	
MCS index ‘1010’	
MCS index ‘1011’	
MCS index ‘1100’	
MCS index ‘1101’	
MCS index ‘1110’	
MCS index ‘1111’	

15.3.x.y.2 Open loop power control

When the open-loop power control is used, the tone power shall be determined for the UL transmission as (2) (in decibels). This open-loop power control shall be applied for the all UL bursts.

$$P = NI + \alpha L + C/N - 10\log_{10}(R) + P\_offset_{MS} + P\_offset_{BS} \qquad (2)$$

where

- P is the TX power level (dBm) per subcarrier for the current transmission, including AMS's Tx antenna gain.
- NI is the estimated average power level (dBm) of the noise and interference per subcarrier at ABS, not including ABS's Rx antenna gain.
- α is the fitting factor for the path loss, controlled by ABS with power control message. The value of α is within 0~1, and its initial value is 1.
- L is the estimated average current UL propagation loss. It shall include AMS's Tx antenna gain and path loss, but exclude the ABS's Rx antenna gain.
- C⁄N is the normalized C/N of the modulation/FEC rate for the current transmission, as appearing in Table 1. Table 1 can be modified as [TBD].
- R is the number of repetitions for the modulation/FEC rate.
- P_Offset_{MS} is the correction term controlled by AMS.
- P_Offset_{BS} is the correction term for AMS-specific power offset. It is controlled by ABS with power control messages. When P_Offset_{BS} is set through [TBD], it shall include ABS's Rx antenna gain. The P_Offset_{BS} value can be used by ABS to control intercell interference.

The estimated average current UL propagation loss, L, shall be calculated based on the total power received on the active subcarriers of the frame preamble, and with reference to the [ABS_EIRP,TBD] parameter sent by the ABS.

The default normalized C/N values per modulation are given by Table 1. The operating parameters [ABS_EIRP, TBD] is signaled by [TBD] and NI is signaled by [TBD].

The P_Offset_{BS} can be updated according to the offset value sent by ABS.

The actual power setting shall be quantized to the nearest allowable value, subject to the specification. For each transmission, the AMS shall limit the power, as required to satisfy the spectral masks and EVM requirements.

--- Text End ---